U. S. DEPARTMENT OF AGRICULTURE
Agricultural Research Administration
Bureau of Animal Industry and
Bureau of Human Nutrition and Home Economics

EFFECT OF FEEDING CERTAIN FISH PRODUCTS ON THE ODOR AND FLAVOR OF ROASTED TURKEYS

In recent years a considerable quantity of fish oils and fish meals has been fed to turkeys and has improved growth of the birds and efficiency of feed utilization. However, reports by consumers of fishy flavor in the flesh of roasted turkeys have followed the increase use of these feeds. To an industry depending for its existence on the production of a highly palatable food, such reports are significant. Unless the production of off-flavored turkeys is stopped, the growth and profitableness of the turkey industry may be adversely affected.

That the fishy flavor found in the flesh of turkeys has come mostly from the inclusion of fish products in the diet has been generally accepted. The possibility that a fishy flavor may be produced by the feeding of certain nonfish products cannot, however, be ignored. Fishy flavor has been found in linseed oil and in milk and butter that have been in no way contaminated with fish or produced by animals fed fish products.

In turkeys fed fish meals or fish oils, it appears that the substance producing fishy flavor is present in the fish products and is absorbed into the turkey's body, where it is deposited in the fat. It is also possible that a certain chemical product in the fish products reacts with unsaturated fat acids set free in the turkey's intestine during digestion to form products responsible for fishy flavor. These compounds that produce a fishy flavor, whether obtained directly from the feed or produced in the intestines, are presumably carried by the blood stream to all parts of the bird's body and deposited in the fatty tissues. There is also the possibility that post mortem changes may foster the production of fishiness in the digestive tract and that this fishiness may be transmitted to the meat, especially when holding conditions are not ideal.

In no previous investigation had comparisons of the effect of a number of commonly used fish products on the flavor of cooked turkeys been made in any one trial. Nor had it been determined whether a fishy flavor or odor would persist in turkey meat for more than 8 weeks after fish products were removed from the diet. Such information would be of value in determining the proper use of fish products for turkeys. To obtain this information, as well as to determine the influence of sex on the occurence of fishy flavor and the parts of the carcass in which this flavor is strongest, experiments were conducted at the United States Department of Agriculture, Beltsville Research Center, Beltsville, Md. The fish products tested were cod-liver oil, fortified cod-liver oil, four common fish meals, and a combination of cod-liver oil and sardine meal. The diets used are shown in table 1.

Sixteen lots consisted of 20 birds each of like age and comparable weight and ancestry were fed experimental diets. Eight lots contained males

and eight contained females. The birds were crossbred involving Bronze, White Holland, Black, and wild turkeys. Each diet was fed to one lot of toms and and one lot of hens. The experiment was started when the birds were 8 weeks old and experimental diets were used from that age to the age of 26 weeks, after which diet No. 88, containing no fish products, was used in all lots to the conclusion of the experiment.

At the end of the twenty-sixth week and weekly thereafter for 9 weeks, a male and a female were selected at random from the lots fed each of the eight diets; during the tenth week one male turkey from each of diets 90, 91, 93 and 94 and one female from each of diets 90,91,92, and 93; and during the eleventh week, one male from each of diets 90, 91, and 94 and one female from each of diets 89, 91, 92, 93, and 95. The selected birds were fasted overnight, slaughtered, dry-picked, full drawn, and held at about 32°F. for from 4 to 6 days after slaughtering before being cooked. Both hot and cold samples were tested for palatability by a number of persons some of whom had had previous experience in test tasting and some of whom had not. Samples of breast, thigh, skin and of gravy were made of the hot meat and of the breast, thigh, wing, leg, and oyster of the cold meat. Fishy or other objectionable odors were recorded as the turkeys were being turned while roasting.

In table 2 are presented data on the proportion of turkeys from the various diet groups that were observed to have fishy odors and other off-odors. These occured in some of the turkeys in each group except the control and the sardine-meal diets.

The percentage of fishy and other off-flavors, based on the total number of portions -- 526 in the hot samples and 200 in the cold samples -- are shown in table 4. In the hot samples fishiness was reported in all diet groups. The percentages for the control and sardine-meal groups were practically equal and were much smaller than for the others. The fortified cod-liver-oil diet produced approximately 2½ times as much fishiness as the control diet. These data (table 4) indicate that all fish products involved except sardine meal may be regarded as producing fishy flavor. Later investigations show that a mild though definite fishy flavor may be produced in turkey meat by feeding sardine meal. Therefore, it seems advisable to limit its use to 5 percent or less of the total diet. In standard 20 to 22-percent protein growing mashes fed with grain, this would amount to approximately 8 percent and in standard 32-percent protein growing concentrates fed with grain, to 12 percent.

In the cold samples fishiness was recognized in equal but very small amounts in the groups fed cod-liver oil, fortified cod-liver oil, and menhaden meal. As a producer of fish flavor, the diet containing cod-liver oil and sardine meal was the highest; even so, its percentage was low.

The date in tables 2 and 4 show that the control and sardine-meal diets were the best for the production of desirable flavor and odor in hot turkey meat and that the diets contaning cod-liver oil and cod-liver oil with sardine meal were the poorest. Data for the cold samples tend to confirm this.

To determine how long fishy odors and flavors persisted after fish products had been eliminated from the diets, the data obtained during the

cooking of all birds were used and percentages were calculated for three 4-week periods, 0 to 3, 4 to 7, and 8 to 11. The data on fishy odors are given in table 3 and show that the percentages were not consistently related to the number of weeks elapsing after removal of fish products from the diets. Data for the diet groups showed individual differences among the turkeys in occurence of fishy odor as well as in the gradual disappearance produced by lengthening the time interval after removal of the fish products from the diets. However, none of the nine birds fed fortified cod-liver oil, herring meal, menhaden meal, and whitefish meal that were tested 10 and 11 weeks after removal of these products had off-odor. Both of the diets containing poultry-grade cod-liver oil produced a fairly uniformly high percentage of birds with fishy odor throughout the entire 12-week period.

Data on fishy flavor were also calculated for the same three 4-week periods and are shown in table 5 for the hot samples and in table 6 for the cold samples. There was a definite and fairly consistent tendency for the percentage of reports of fishy flavor to be least during the 8-to 11-week period for all diets and for all portions of both sexes except the skin in the females (table 5). As a whole, however, fishy flavors did not disappear completely.

The data on cold samples (table 6) show a fairly consistent lessening of the percentage of off-flavors form one 4-week period to the next, thereby confirming the trend shown in the data obtained from the hot samples. No fishy flavor was detected in the cold samples after the 4th week.

The conclusion from this study is that when the feeding of fish products to turkeys is discontinued at the age of 26 weeks, a period of 11 weeks is not sufficient to insure the complete disappearance of fishy flavor, once it is produced. It has been pointed out that individual variations were found in the occurance of fishy odor and flavor in turkeys. In each of the groups for which there was a high percentage of fishy odor and flavor, some birds were entirely free of them 1 or 2 weeks after removal of fish products from the diets. For this reason, recommendations as to the length of time needed for undesirable odors and flavors to disappear ought not to be based on the failure to detect them in 1 or 2 turkeys within a short time after fish products have been removed from the diet.

In this experiment as a whole, female turkeys were found to have more fishy flavor than the males. The average results for the hot samples from birds fed the eight experimental diets for the entire period 0-11 showed that females had 13.6 percent of fishy flavor and males 9.5 percent. The average results from the cold samples for all diets combined for the entire period showed that females had 7.0 percent of off-flavors and males had 5.5 percent. Since fishy flavor is found more often and is of greater intensity in the fatty tissue of turkeys than in the lean portions, it is probable that the difference between sexes with regard to fishy flavor is due to the fact that the females usually contain more fat than the males at 28 weeks of age.

The following conclusions regarding the use of fish oils and meals in growing diets for turkeys are made as a result of this experiment:

1. Fish oils of all kinds should be omitted from the diets of turkeys from 8 weeks of age until marketing. Vitamins A and D, found in fish oils, may now be supplied form other sources. If it is necessary to feed fish

oils, the quantity should be restricted to one-eight percent or less of the total diet.

2. It is inadvisable to feed menhaden, whitefish, or herring to market turkeys beyond the age of 8 weeks.

3. When sardine is fed, the quantity should be limited to 5 percent or less of all-mash growing diets, to 8 percent or less of the-20-to-22 growing mashes, and to 12 percent or less of 32-percent protein concentrate mashes normally fed in connection with grain.

Table 1. - Composition of experimental diets fed to various lots of turkeys from the ninth to twenty-sixth week, inclusive

Ingredient	Diet 88	Diet 89	Diet 90	Diet 91	Diet 92	Diet 93	Diet 94	Diet 95
	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
Wheat bran	5	5	5	5	5	5	5	5
Wheat middlings	15	15	15	15	15	15	15	15
Oats, pulverized	20	20	20	20	20	20	20	20
Yellow corn, coarsely ground	31	30	30.75	30	31	31	31	31
Alfalfa-leaf meal, dehydrated	7	7	7	7	7	7	7	7
Corn gluten meal	5	5	5	5	5	5	5	5
Meat scrap, 55 percent protein	10	10	10	-	-	-	-	-
Skim milk, dried	5	5	5	5	5	5	5	5
Oystershell, ground	1	1	1	1	1	1	1	1
Salt	1	1	1	1	1	1	1	1
Sardine meal, vacuum-dried	-	-	-	10	10	-	-	-
Menhaden meal, flame-dried	-	-	-	-	-	10	-	-
Whitefish meal, vacuum dried	-	-	-	-	-	-	10	-
British Columbia herring meal	-	-	-	-	-	-	-	10
Cod-liver oil, poultry grade	-	1	-	-	1	-	-	-
Cod-liver oil, fortified	-	-	.25	-	-	-	-	-
Total	100	100	100	100	100	100	100	100

Table 2. - Proportion of turkeys, on each diet, with fishy odors and other off-odors, as observed during roasting (10 male and 10 female turkeys on each diet)

Diet No.	Turkeys with		
	Fishy off-odors	Other off-odors	Total
	Percent	Percent	Percent
88 (control)	0	0	0
89 (cod-liver oil)	75	0	75
90 (fortified cod-liver oil)	15	10	25
91 (cod-liver oil and sardine meal)	65	5	70
92 (sardine meal)	0	0	0
93 (menhaden meal)	25	5	30
94 (whitefish meal)	45	0	45
95 (herring meal)	20	0	20

Table 3. - Proportion of hot roasted turkey, on each diet, with fishy odor at various intervals after removal of fish products from the diet (4 male and 4 female turkeys turkeys in each 4-week period) except as noted in the text for 8-11 weeks

Diet No.	Turkeys with fishy odors after --		
	0-3 weeks	4-7 weeks	8-11 weeks
	Percent	Percent	Percent
88 (control) ----------	0	0	0
89 (cod-liver oil) - - - - - - - - -	87.5	75.0	60.0
90 (fortified cod-liver oil) - - - -	0	12.5	28.6
91 (cod-liver oil and sardine meal) -	50.0	62.5	75.0
92 (sardine meal) - - - - - - - - - -	0	0	0
93 (menhaden meal) - - - - - - - - - -	0	37.5	28.6
94 (whitefish meal) - - - - - - - - -	37.5	50.0	33.3
95 (herring meal) - - - - - - - - - -	25.0	12.5	20.0

Table 4. - Percentages of fishy flavor and other off-flavors 1/ of roasted turkeys by experimental diet

Diet No.	Hot samples 2/			Cold samples 3/		
	Fishy flavor	Other off-flavor	Total off-flavor	Fishy flavor	Other off-flavor	Total off-flavor
	Percent	Percent	Percent	Percent	Percent	Percent
88 (control)	2.7	7.4	10.1	0.0	5.5	5.5
89 (cod-liver oil)	32.2	9.1	41.3	.5	10.0	10.5
90 (fortified cod-liver oil)	7.0	7.4	14.4	.5	4.5	5.0
91 (cod-liver and sardine meal)	40.4	9.7	50.1	4.5	7.0	11.5
92 (sardine meal)	2.8	6.3	9.1	0.0	4.5	4.5
93 (mehaden meal)	10.2	8.0	18.2	.5	6.5	7.0
94 (whitefish meal)	15.0	9.9	24.9	0.0	2.5	2.5
95 (herring meal)	7.6	9.0	16.6	0.0	5.5	5.5

1/ Based on the total number of portions, which was 526 for the hot samples and 200 for the cold samples.

2/ Breast, thigh, gravy, and skin of 10 male and 10 females turkeys combined.

3/ Breast, wing, thigh, drumstick, and oyster of 10 male and 10 female turkeys combined.

Table 5. - Proportion of reports indicating fishy flavor 1/ in (various) portions of hot roasted turkey at regular intervals after removal of fish products from diet (4-male and 4-female turkeys in each 4-week period except as noted in the text) for 8-11 weeks

Diet No.	Portion of turkey	Proportion of reports 2/ indicating fishy flavor 2/ after					
		0-3 weeks		4-7 weeks		8-11 weeks	
		males	females	males	females	males	females
		Pct.	Pct.	Pct.	Ptc.	Pct.	Pct.
88 (control)	Breast	0.0	0.0	0.0	10.0	0.0	0.0
	Thigh	0.0	0.0	0.0	5.0	0.0	0.0
	Gravy	0.0	0.0	0.0	5.0	0.0	0.0
	Skin	0.0	0.0	10.0	0.0	0.0	10.0
	Average	0.0	0.0	2.5	5.0	0.0	2.5
89 (cod-liver oil)	Breast	5.0	0.0	0.0	20.0	0.0	13.3
	Thigh	30.0	45.0	20.0	60.0	20.0	26.7
	Gravy	25.0	15.0	15.0	5.0	10.0	13.3
	Skin	20.0	80.0	50.0	60.0	30.0	86.7
	Average	20.0	28.6	21.3	36.3	17.5	35.0
90 (fortified cod-liver oil)	Breast	0.0	0.0	0.0	0.0	0.0	0.0
	Thigh	0.0	20.0	0.0	0.0	0.0	6.7
	Gravy	0.0	5.0	5.0	0.0	0.0	0.0
	Skin	10.0	0.0	5.0	20.0	0.0	26.7
	Average	1.4	4.1	2.5	5.0	0.0	8.3
91 (cod-liver oil and sardine meal)	Breast	15.0	30.0	10.0	10.0	0.0	10.0
	Thigh	40.0	55.0	40.0	60.0	30.0	30.0
	Gravy	20.0	55.0	15.0	10.0	10.0	0.0
	Skin	70.0	80.0	70.0	80.0	30.0	25.0
	Average	31.4	51.4	33.8	40.0	17.5	16.3
92 (sardine meal)	Breast	5.0	0.0	0.0	0.0	0.0	0.0
	Thigh	0.0	0.0	0.0	5.0	0.0	0.0
	Gravy	5.0	0.0	0.0	5.0	0.0	5.0
	Skin	0.0	0.0	0.0	5.0	0.0	20.0
	Average	2.9	0.0	0.0	3.8	0.0	6.3
93 (menhaden meal)	Breast	10.0	5.0	0.0	5.0	0.0	0.0
	Thigh	5.0	20.0	15.0	10.0	6.7	15.0
	Gravy	0.0	5.0	5.0	0.0	6.7	0.0
	Skin	10.0	0.0	10.0	45.0	6.7	10.0
	Average	5.7	8.6	7.5	15.0	5.0	6.3
94 (whitefish meal)	Breast	0.0	10.0	0.0	0.0	0.0	0.0
	Thigh	5.0	15,0	15.0	15.0	5.0	0.0
	Gravy	15.0	10.0	10.0	0.0	5.0	0.0
	Skin	60.0	20.0	70.0	15.0	10.0	0.0
	Average	14.3	12.9	23.8	7.5	5.0	0.0
95 (herring meal)	Breast	0.0	0.0	0.0	10.0	0.0	0.0
	Thigh	15.0	0.0	0.0	10.0	0.0	0.0
	Gravy	0.0	5.0	0.0	5.0	0.0	6.7
	Skin	0.0	0.0	5.0	25.0	0.0	20.0
	Average	4.3	1.4	1.3	12.5	0.0	6.7

1/ Based on total number of reports for each portion tasted.

2/ Calculated as the weighted-average percentage of the number possible if every judge had reported fishy flavor in every portion judged.

Table 6. - Proportion of reports indicating off-flavor (fishy and other) 1/ in various portions of cold roast turkeys at regular intervals after removal of fish products from diet (4 male and 4 female turkeys in each 4-week period except as noted in the text for 8-11 weeks

Diet No.	Portion of turkey	Proportion of reports indicating off-flavor 2/ after: 0-3 weeks		4-7 weeks		8-11 weeks	
		males	females	males	females	males	females
		Pct.	Pct.	Pct.	Pct.	Pct.	Pct.
83 (control)	Breast and wing	12.5	6.3	0.0	0.0	0.0	12.5
	Thigh, leg, and oyster	12.5	8.3	0.0	8.3	0.0	0.0
	Average	12.5	7.5	0.0	5.0	0.0	5.0
89 (cod-liver oil)	Breast and wing	12.5	0.0	0.0	18.8	0.0	0.0
	Thigh, leg, and oyster	20.8	16.7	4.2	25.0	0.0	0.0
	Average	17.5	10.0	2.5	22.5	0.0	0.0
90 (fortified cod-liver oil)	Breast and wing	6.3	0.0	6.3	0.0	0.0	0.0
	Thigh, leg, and oyster	4.2	12.5	12.5	4.2	0.0	0.0
	Average	5.0	7.5	10.0	2.5	0.0	0.0
91 (cod-liver oil and sardine meal)	Breast and wing	18.8	25.0	0.0	12.5	0.0	0.0
	Thigh, leg, and oyster	4.2	41.7	0.0	12.5	0.0	0.0
	Average	10.0	35.0	0.0	12.5	0.0	0.0
92 (sardine meal)	Breast and wing	18.8	6.3	0.0	0.0	0.0	0.0
	Thigh, leg, and oyster	8.3	0.0	0.0	8.3	8.3	16.7
	Average	12.5	2.5	0.0	5.0	5.0	10.0
93 (menhaden meal)	Breast and wing	25.0	12.5	0.0	0.0	0.0	6.3
	Thigh, leg and oyster	16.7	8.3	4.2	0.0	0.0	0.0
	Average	20.0	10.0	2.5	0.0	0.0	2.5
94 (whitefish meal)	Breast and wing	6.3	6.3	0.0	0.0	6.3	0.0
	Thigh, leg, and oyster	4.2	0.0	4.2	0.0	4.2	0.0
	Average	5.0	2.5	2.5	0.0	5.0	0.0
95 (herring meal)	Breast and wing	12.5	0.0	6.3	6.3	0.0	16.7
	Thigh, leg, and oyster	8.3	4.2	0.0	4.2	0.0	11.1
	Average	10.0	2.5	2.5	5.0	0.0	13.3

1/ Based on total number of reports for portions tasted.

2/ Calculated as the weight-average percentage of the number possible if every judge had reported off-flavor in every portion judged.